Application No. 10/043,534

Reply to Office Action

REMARKS/ARGUMENTS

The Pending Claims

The pending claims are directed to a system for polishing a substrate comprising a liquid carrier, ammonium oxalate, a hydroxy coupling agent, fumed silica, and a polishing pad, wherein the system does not comprise an oxidizing agent, and wherein the polishing system has a pH of about 8-12. The pending claims are also directed to a method of polishing a substrate using the aforementioned polishing system. Claims 1-3, 5, 6, and 9-27 currently are pending.

Discussion of the Claim Amendments

Claim 1 has been amended to recite that the polishing system has a pH of about 8-12. Support for this amendment can be found in the specification at paragraph 21. No new matter has been added by way of this amendment

Summary of the Office Action

Claims 1-3, 6, and 15 stand rejected 35 U.S.C. § 102(e) as allegedly anticipated by U.S. Patent 6,190,443 (Ohashi et al.) (hereinafter "the Ohashi '443 patent"). Claims 1-3, 5, 6, 10-13, 15-18, 20-24, 26, and 27 stand rejected under 35 U.S.C. § 103(a) as allegedly unpatentable over Motonari et al. (i.e., U.S. Patent 6,447,695) (hereinafter "the Motonari '695 patent") in view of Sinha et al. (i.e., U.S. Patent 6,551,935) (hereinafter "the Sinha '935 patent"). Claims 9 and 14 stand rejected as allegedly unpatentable over the Motonari '695 patent in view of the Sinha '935 patent and further in view of Allman et al. (i.e., U.S. Patent 6,541,383) (hereinafter "the Allman '383 patent"). In addition, claims 19 and 25 stand rejected as allegedly unpatentable over the Motonari '695 patent in view of the Sinha '935 patent and further in view of Ni (i.e., U.S. Patent 6,503,766) (hereinafter "the Ni '766 patent").

Discussion of the Anticipation Rejection

The Office Action relies on the Ohashi '443 patent for its alleged disclosure of an aqueous chemical-mechanical polishing composition comprising water (e.g., a liquid carrier), fumed silica, ammonium oxalate, and a "hydroxyethylethyl/hydroxyl coupling agent." The

Page 5 of 9

Application No. 10/043,534

Office Action also asserts that the Ohashi '443 patent is silent regarding the use of an oxidizing agent in the disclosed polishing composition.

The pending claims recite a system for polishing a substrate comprising (i) a liquid carrier, (ii) ammonium oxalate, (iii) a hydroxy coupling agent, (iv) fumed silica, and (v) a polishing pad, wherein the system does not comprise an oxidizing agent. The Ohashi '443 patent does not disclose a polishing system comprising ammonium oxalate and a hydroxyl coupling agent, wherein the system does not comprise an oxidizing agent. The Ohashi '443 patent discloses a polishing composition comprising an iron chelate complex that can be provided *per se*, or a water-soluble iron salt such as iron ammonium oxalate and a chelating agent can be dissolved in the polishing composition, so that the chelating agent will be coordinated on the iron ion in the composition.

Contrary to the Office Action's assertions, the Ohashi '433 patent does not disclose a hydroxy coupling agent, as recited in the pending claims. The Office Action asserts that the Ohashi '433 patent discloses a "hydroxyethylethyl/hydroxyl coupling agent" and references col. 4, lines 30-36, therein. However, Applicants point out that the referenced section of the Ohashi '433 patent is directed to the particle size of abrasives useful in the disclosed polishing composition and not to a coupling agent. The Ohashi '433 patent teaches an additive including hydroxyethylcellulose (the Ohashi '433 patent at col. 6, line 39), but this additive is not a hydroxy coupling agent. The present specification describes suitable hydroxy coupling agents as including, for example, coupling agents that can be used to reduce the surface hydroxyl density of metal oxide abrasives. Examples of suitable hydroxy coupling agents include, for example, silane coupling agents, aluminum coupling agents, organotitanium coupling agents, and organophophorous coupling agents (the present specification at paragraph 11). Not only has the Office Action failed to properly identify any disclosure of a hydroxy coupling agent within the Ohashi '433 patent, but also none of the chemical agents taught in the Ohashi '433 patent could reasonably be considered to be hydroxy coupling agents as that term is defined in the present application. Thus, the Ohashi '433 patent fails to disclose each and every element of pending claim 1 and cannot properly be considered to anticipate claim 1.

Page 6 of 9

Application No. 10/043,534

Reply to Office Action

Pending claims 2, 3, 6, and 15 depend from, and further limit, the subject matter recited in pending claim 1. Thus, the Ohashi '433 patent also fails to disclose each and every element of pending claims 2, 3, 6, and 15 and cannot properly be considered to anticipate claims 2, 3, 6, and 15.

The anticipation rejection is improper and should be withdrawn.

Discussion of the Obviousness Rejections

In rejecting the pending claims on obviousness grounds, the Office Action relies on the Motonari '695 patent for its disclosure of an aqueous dispersion comprising water, an abrasive, and a silane coupling agent (e.g., a hydroxy coupling agent), wherein the aqueous dispersion normally contains no oxidizing agent. The Office Action recognizes that the Motonari '695 patent does not specifically disclose using ammonium oxalate in the aqueous dispersion. The Office Action relies on the Sinha '935 patent for its disclosure of a method of using a planarizing solution comprising ammonium oxalate employed in a polishing system further including a polishing pad and abrasives. Since the Sinha '935 patent is directed to a polishing system for polishing metal with an aqueous dispersion, the Office Action alleges that one of ordinary skill in the art would have found it obvious to modify the aqueous dispersion of the Motonari '635 patent to incorporate ammonium oxalate because the Sinha '935 patent discloses that one or more buffers such as ammonium oxalate may be used to adjust the pH of the solution to a desired level.

The pending claims, as amended, recite a system for polishing a substrate comprising (i) a liquid carrier, (ii) ammonium oxalate, (iii) a hydroxy coupling agent, (iv) fumed silica, and (v) a polishing pad, wherein the system does not comprise an oxidizing agent, and wherein the polishing system has a pH of about 8-12. The Motonari '695 patent teaches that the disclosed polishing compositions can have a pH of 1 to 10, and teaches that the pH can be adjusted with an inorganic or organic acid, but is silent as to the use of a buffering agent. There is no teaching or suggestion in the Motonari '695 patent to incorporate any buffering agent in the polishing composition disclosed therein.

Further, the polishing composition disclosed in the Motonari '695 patent is intended for the polishing of barrier metal layers (e.g., tantalum) at a sufficient rate, without excessively polishing wiring materials such as copper, or excessively polishing insulating

Page 7 of 9

films (the Motonari '695 patent at col. 1, lines 42-51). The Motonari '695 patent teaches that when the pH is acidic, the polishing rate on copper films is slowed while the polishing rate on tantalum layers is accelerated. The Motonari '695 patent further teaches that when the pH is near neutral (e.g., near 7), the polishing rate on copper films is accelerated while the polishing rate on tantalum layers is slowed (the Motonari '695 patent at col. 6, lines 42-44 and 50-57). Thus, to achieve the desired outcome resulting from the use of the polishing composition of the Motonari '695 patent, namely, to polish barrier metal layers at a sufficient rate without excessively polishing wiring materials, the ordinarily skilled artisan is directed to an acidic polishing composition, as polishing compositions having a neutral pH are taught as having an accelerated polishing rate of copper films accompanied by a detrimental decreased polishing rate of tantalum films.

The Sinha '935 patent fails to cure the deficiencies of the Motonari '695 patent. The Sinha '935 patent is generally directed to polishing compositions and methods useful in the polishing of substrates formed from copper and tungsten. Assuming *arguendo* that the ordinarily skilled artisan would somehow be motivated to include a buffer in the polishing composition of the Motonari '695 patent, the ordinarily skilled artisan would learn from the Sinha '935 patent that the disclosed polishing composition desirably has a pH of about 3 to about 7 (the Sinha '935 patent at col. 6, lines 6-8) and that one or more pH control agents or buffers can be used to adjust the pH of the polishing composition to a desired level. When a substrate comprising a copper layer and a tungsten layer is polished using a copper polishing slurry at a pH of about 7, the tungsten layer undesirably is oxidized and dissolved at a faster rate than the adjacent copper layer (the Sinha '935 patent at col. 2, lines 32-48). Thus, the Sinha '935 patent teaches that the pH of the disclosed polishing compositions desirably is an acidic pH so as to provide for oxidation of copper and a barrier material, such as a tungsten-containing material, at substantially the same rates (the Sinha '935 patent at col. 3, lines 25-28).

The Sinha '935 patent further discloses a list of particular buffers including ammonium oxalate. The pH of a 0.1 M aqueous solution of ammonium oxalate, one of the buffers disclosed in the Sinha '935 patent, is 6.4 (source: Material Safety Data Sheet A6072, Mallinckrodt Baker, Inc., Phillipsburg, N.J.). Buffers are selected so that the desired pH is approximately equal to the pK_a for the buffer system (see, e.g., "Buffers (chemistry)" in

Page 8 of 9

Application No. 10/043,534

Reply to Office Action

McGraw-Hill Encyclopedia of Science and Technology, 6th ed., vol. 3, pp. 91-92 (1987), especially p. 92, 1st column, lines 6-10 (copy enclosed)). Since the pK_a of aqueous ammonium oxalate is about 6.4, one of ordinary skill in the art would not have selected ammonium oxalate as a buffer for use in a system with a pH of about 8-12, as recited in the pending claims. Rather, one of ordinary skill in the art would be motivated to select a buffer having a pK_a of about 8 to about 12, depending on the desired pH, which buffer – as a result – would *not* be ammonium oxalate.

The Motonari '695 patent and the Sinha '935 patent, whether considered separately or together, do not teach or reasonably suggest a polishing system comprising a liquid carrier, ammonium oxalate, a hydroxy coupling agent, fumed silica, and a polishing pad, wherein the system does not comprise an oxidizing agent, and wherein the polishing system has a pH of about 8-12. The other references relied upon in the Office Action, namely the Allman '383 patent and the Ni '766 patent, do not cure the deficiencies of the Motonari '695 patent and the Sinha '935 patent with respect to, *inter alia*, the use of ammonium oxalate in a polishing system with a pH of about 8-12. Since the combined references fail to teach or suggest all of the limitations recited in the pending claims, the obviousness rejection of the pending claims is improper and should be withdrawn.

Conclusion

Applicants respectfully submit that the patent application is in condition for allowance. If, in the opinion of the Examiner, a telephone conference would expedite the prosecution of the subject application, the Examiner is invited to call the undersigned attorney.

Respectfully submitted,

John Kilyk, Jr., Reg. No. 30,763
LEYDIG, VOIT & MAYER, LTD.
Two Prudential Plaza, Suite 4900
180 North Stetson Avenue
Chicago, Illinois 60601-6780
(312) 616-5600 (telephone)
(312) 616-5700 (facsimile)

Date: June 5, 2006

Page 9 of 9

PAGE 12/16 * RCVD AT 6/5/2006 10:24:46 AM [Eastern Daylight Time] * SVR:USPTO-EFXRF-5/5 * DNIS:2738300 * CSID:312 616 5700 * DURATION (mm-ss):04-48

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The Indian or water buffalo (*Bubalus bubalis*).

shortest, most splayed horns of any variety (see illus.). Like all buffalo, they have a liking for marshes, where they wallow and become caked with mud that affords protection against insects. Their wide, flattened hooves allow them to·stand firmly on the soft, marshy soil. They are hardy animals, being able to resist the infections and insect-borne diseases of the country, and they can withstand cold so well that they do not need shelters. Their diet consists entirely of reeds, rushes, and other aquatic plants. Domestic herds of 200–300 animals may provide 300 pints (1400 liters) of milk a year. This milk is rich in cream and is used to make butter and yogurt. *SEE MILK.*

Two other Asiatic species related to, but smaller than, the water buffalo are the tamarau (*Anoa mindorensis*), which is indigenous to the Philippines, and the still smaller (40 in. or 1 m high) anoa (*A. depressicornis*), or wild dwarf buffalo, found in the Celebes.

The African buffalo, classed in the genus *Syncerus*, was very numerous until the turn of the century, when the infectious disease rinderpest caused many deaths. They are still abundant though widely hunted by the natives. There are several varieties of African buffalo, and it is thought that all may be subspecies of *S. caffer*, the Cape buffalo, which attains a height of about 5 ft (1.5 m) at the shoulder and weighs more than 1500 lb (67.5 kg). They live in the open country of central, eastern, and southern Africa. Mating occurs early in the year, and a single calf is born after a gestation period of 11 months. Except for its size, this animal is difficult to distinguish from the rare dwarf or forest buffalo (*S. caffer nanus*), which is less than 4 ft (1.2 m) high at the shoulder and weighs a little more than 400 lb (180 kg). It lives in marshy, forested areas of western Africa, where it is known as the bush cow. This species has not been domesticated and occurs in herds of up to 1000. *SEE ARTIODACTYLA; BISON; MAMMALIA; MUSK-OX; YAK.*

Charles B. Curtin

Buffers (chemistry)

Solutions selected or prepared to minimize changes in hydrogen ion concentration which would otherwise tend to occur as a result of a chemical reaction. In general, chemical buffers are systems which, once constituted, tend to resist further change due to external influences. Thus it is possible, for example, to make buffers resistant to changes in temperature, pressure, volume, redox potential, or acidity. The commonest buffer in chemical solution systems is the acid-base buffer.

Chemical reactions known or suspected to be dependent on the acidity of the solution, as well as on other variables, are frequently studied by measurements in comixture with an appropriate buffer. For example, it may be desirable to investigate how the rate of a chemical reaction depends upon the hydrogen ion activity (pH). This is accomplished by measurements in several buffer systems, each of which provides a nearly constant, different pH. Alternatively, it may be desirable to measure the effects of other variables on a pH-sensitive system, by stabilizing the pH at a convenient value with a particular buffer.

Effectiveness. Buffer action depends upon the fact that, if two or more reactions coexist in a solution, then the chemical potential of any species is common to all reactions in which it takes part, and may be defined by specification of the chemical potentials of all other species in any one of the reactions. To be effective, a buffer must be able to respond to an increase as well as a decrease of the species to be buffered. In order to do so, it is necessary that the proton transfer step of the buffer be reversible with respect to the species involved, in the reaction to be buffered. In aqueous solution the proton transfer between most acids, their conjugate bases and water, is so rapid and reversible that the dominant direct source of protons for a chemical reaction is H_3O^+, the hydronium ion.

An acid-base buffer reaction in water is defined by reversible reaction (1), and the equilibrium constant

$$BH^+ + H_2O \rightleftharpoons B + H_3O^+ \qquad (1)$$
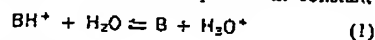
K_a shown by Eq. (2).

$$K_a = \frac{[H_3O^+][B]}{[BH^+][H_2O]} \qquad (2)$$

In Eq. (2) the square brackets designate the activity of the species involved. In normal concentrations of buffer (0.1 mole/liter) the activity of the solvent water is essentially constant and approximately that of pure water (55.5 M). Thus the position of the equilibrium may be defined by specifying the activity of any two of the three variable species in reaction (1). Normally this is by means of the equilibrium expression shown as Eq. (3) which, upon converting to a logarithmic

$$[H_3O^+] = K_a \frac{[BH^+]}{[B]} \qquad (3)$$

form, can be reduced to Eq. (4). Here f is the fraction

$$pH = pK_a - \log\frac{(1-f)}{f} - \log\frac{\gamma_{BH^+}}{\gamma_B} \qquad (4)$$

of the total buffer concentration, $(BH^+) + (B)$ existing as B, and γ is the activity coefficient relating activity a to concentration X. This relation is shown by Eq. (5). Thus a buffer pH is approximately defined

$$a_x = \gamma_x(X) \qquad (5)$$

by the dissociation constant K_a of the weak acid system and the ratio of acid to conjugate base concentrations. However, the third term in Eq. (4) indicates that the pH is dependent on the change in activity coefficients with concentration. Effects of this dependency may be eliminated in practice by providing a high and essentially invariant ionic environment in the form of an added pH-neutral strong electrolyte such as KNO_3 or $NaCl$.

Buffer capacity π is defined as the change in added H_3O^+ necessary to produce a given change in pH, $d[H_3O^+]/dpH$. Since the buffer comes to equilibrium

92 Buffing

with added H_3O^+, $1/\pi$ may also be defined as dpH/df. Inspection of Eq. (4) shows $1/\pi$ to be a minimum when f = f; hence a given buffer system has its highest capacity in a solution composed of equal parts BH^+ and B, and the capacity is directly proportional to the concentrations of BH^+ and B. For these reasons buffers are normally used at concentrations 10–100 times higher than the system to be controlled and, if possible, are selected so that the desired pH is approximately equal to pK_a for the buffer system. As a general rule, weak acid systems are not used to stabilize solutions whose pH is more then 2 pH units removed from pK_a, to ensure that the ratio of BH^+ to B will fall in the range 100–0.01.

Water as solvent. Buffers are particularly effective in water, because of the unusual properties of water as a solvent. Its high dielectric constant (80) tends to promote the existence of formally charged ions (ionization). Because it has both an acidic (H) and a basic (O) group, it may form bonds with ionic species leading to an organized sheath of solvent surrounding an ion (solvation). Water also tends to self-ionize to form its own conjugate acid-base system as shown by Eq. (6b), in which K_{ap} is the autoprotolysis constant.

$$2H_2O \rightleftharpoons H_3O^+ + OH^- \qquad (6a)$$
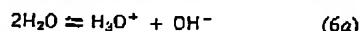
$$K_{ap} = [H_3O^+][OH^-] = 10^{-14} \qquad (6b)$$

The strength of an acid (or base) in solvent water cannot be separated from reaction (6a), and the familiar acid (or base) dissociation equilibrium reaction of reaction (1). Strong acids are those for which the K_a of Eq. (2) is very large; weak acids do not completely transfer the proton to water. The strongest acid which may exist in water is H_3O^+; the strongest base is OH^-. Thus, the maximum range of acid level which a solvent can support is governed by its own acid-base properties. In water this range is 14 pH units, or 14 orders of magnitude change in activity of H_3O^+. See SUPERACID.

The mechanism of buffer action may be regarded as a sequence of the proton transfer steps implied in reaction (1) coupled with reaction (6a). For example, the result of the chemical production or deliberate addition of an acid, HA, is to cause the water autoprotolysis reaction and the buffer acid reaction to respond to the change shown by reactions (7) and (8). Addi-

$$HA + H_2O \rightleftharpoons H_3O^+ + A^- \qquad (7)$$

$$H_3O^+ + B \rightarrow BH^+ + H_2O \qquad (8)$$
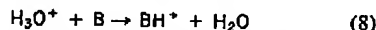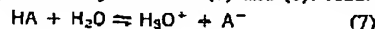
tion of a base would be accommodated by the reverse of (7) and (8). The effect of adding HA depends on the position of the equilibrium shown in reaction (7); buffer capacity π is usually defined in terms of H_3O^+ added because H_3O^+ is the strongest possible acid in aqueous solution, and would tend to create the maximum possible change in solution pH per mole of added acid. If HA is relatively weak so its degree of dissociation, in reaction (1), is small, its effective H_3O^+ addition may be calculated through Eq. (9),

$$[H_3O^+] \approx \sqrt{K_a C_a} \qquad (9)$$

where C_a is the concentration of added HA. A simple calculation using Eq. (9) shows that a given buffer solution will undergo the same change in pH for the addition of 0.1 mole/liter of a weak acid such as acetic acid ($K_a = 10^{-5}$) as for the addition of 0.01 mole/liter of strong acids such as HCl, $HClO_4$, or HNO_3.

In studies of rates of chemical reactions at constant pH, it is necessary that the proton transfer processes of the buffer acid and base and the solvent be rapid with respect to the primary reaction. The phosphate ($HPO_4^{2-}-PO_4^{3-}$) and carbonate ($HCO_3^--CO_3^{2-}$) systems, among others, sometimes give anomalous effects because this condition may not be obtained. Buffer rate effects are manifested in different reaction rates for a chemical system in two different buffers or otherwise identical ionic strength and nominal (equilibrium) pH. Later evidence seems to suggest that buffers of low-charge type, for example, $NH_3-NH_4^+$, react more rapidly than high-charge types such as $HPO_4^{2-}-PO_4^{3-}$. See ACID AND BASE; ACID-BASE INDICATOR; IONIC EQUILIBRIUM.

A. M. Hartley

Bibliography. J. J. Cohen and J. P. Kassirer, Acid-Base, 1982; H. A. Laitinen, Chemical Analysis, 2d ed., 1975; D. D. Perrin and B. Dempsey, Buffers for pH and Metal Ion Control, 1979.

Buffing

The smoothing and brightening of a surface by an abrasive compound pressed against it by means of a soft wheel or belt. The abrasive is a fine powder or flour mixed with tallow or wax to form a smooth composition or paste. This is applied as required to the buffing wheel or belt, made of a pliable material such as soft leather, linen, or felt. Buffing is accomplished on the same types of machines as polishing and frequently both types of wheels are included on one machine. See ABRASIVE; POLISHING.

Alan H. Tuttle

Buhrstone mill

A mill for grinding or pulverizing, in which a flat siliceous rock, generally of cellular quartz, rotates against a stationary stone of the same material. The Buhrstone mill is one of the oldest types of mill and, with either horizontal or vertical stones, has long been used to grind grains and hard materials. Grooves in the stones facilitate the movement of the material.
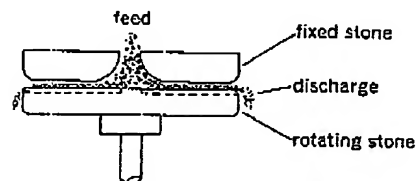
Buhrstone mill. Material moves toward outer edge of the stones where finely ground product is discharged.

Fineness of the product is controlled by the pressure between the stones and by the grinding speed. A finely ground product is achieved by slowly rotating the stone at a high pressure against the materials and its mate (see illus.). The capacity, or output, of a Buhrstone mill is low and its power requirements are high. The stones require frequent maintenance, even when grinding only slightly abrasive materials. See CRUSHING AND PULVERIZING; GRINDING MILL.

George W. Kessler